NANOSIMS IMAGING OF VOLATILE ELEMENTS (H, C, F AND S) IN SHERGOTTITES.

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Introduction: Volatiles, especially water, play a critical role in the evolution of Mars and other planetary bodies. Though the detection limit and spatial resolution in measuring volatiles in different phases of Martian meteorites have been greatly improved using ion microprobes (SIMS), it remains a challenge to accurately determine volatile concentrations due to contamination by terrestrial volatiles. Most Martian meteorites experienced cracking and shattering from the high-pressure shock either on the Martian surface and/or when coming to Earth. Martian meteorites generally contain volatiles in cracks even after careful sample preparation for SIMS analysis. We used the Cameca NanoSIMS 50L at Carnegie Institution of Washington to image volatile (H, C, F and S) distributions in two shergottite meteorites, LAR 06319 (L2) and Y-980456 (Y3). The mapping of volatiles in these meteorites greatly assisted us in understanding the distribution of volatile contamination and in improving future volatile measurement methods.

Results: In most previous measurements of volatiles, great attention has been paid to avoiding contamination with careful sample preparation, prolonged vacuum pumping of the sample, high primary beam pre-sputtering and limiting the signal collecting area to the central portion of the rastered area. We applied volatile mapping analysis of 30-50 μm^2 in selected regions of L2 and Y3 with 100 pA-10 nA primary beam intensities using the NanoSIMS. These analyses show the following results:

1. Higher volatile counts (in particular H and C) are detected in cracks. These volatile signals can be several orders of magnitude higher than the minerals or melts in these meteorites. There are many fewer cracks in impact melts (e.g. L2-2) than in olivine and pyroxene minerals, which is consistent with previous SEM observations.
2. Huge amounts of H and C can be seen near the edge of a sputtered crater. This edge effect can be minimized with pre-sputtering a larger area than the region to be analyzed.
3. The count rates of ^{16}OH ions in Cr spinels in Y3 and L2 are orders of magnitude higher than other phases. Since these spinels should not contain abundant H or OH, their high of ^{16}OH count rates indicate much higher ion yields than in other minerals. We also found that ^{16}OH ions give higher count rates than H ions by up to factors of 2-3 times in other phases.